22 The Economics of Food Safety: The 2006 Foodborne Illness Outbreak Linked to Spinach

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Introduction

On September 14, 2006, the U.S. Food and Drug Administration (FDA) announced that consumers should not eat bagged spinach because of a foodborne illness outbreak of the potentially deadly bacterium *Escherichia coli* O157:H7. Retail and food-service firms immediately cleared bagged spinach from their shelves and menus. Spinach sales closed down overnight. By the time the outbreak was over, 204 people became ill across 26 states and 1 province in Canada, 104 people were hospitalized, 31 developed the serious complication of Hemolytic Uremic Syndrome (HUS), and 3 died. Eventually, the FDA determined that one 2.8-acre field was the most likely source of all the contaminated spinach, but it could not identify the method of contamination. In the wake of the outbreak, the spinach—and more generally leafy greens—industry, retailers, and food-service buyers, and the government reassessed their strategies to reduce the risk of microbial contamination (Calvin 2007). The widespread impact of a small quantity of contaminated spinach emphasizes the fact that there can be significant public health effects and economic spillovers from the actions of an individual grower.

Although spinach and other leafy greens have been associated with numerous foodborne illness outbreaks, the risk of becoming ill from spinach is low. In 2005, U.S. consumers ate 680 million pounds of fresh spinach and the load of contaminated spinach associated with the outbreak totaled only 1,002 pounds. However, leafy greens are the most likely produce category to be associated with an outbreak. From 1996 to 2006, leafy greens have accounted for 34% of all outbreaks due to microbial contamination traced back to a specific fruit or vegetable, 10% of illnesses, and 33% of deaths (Table 22.1). Of the 24 outbreaks traced to leafy greens in the United States since 1996, 20 have been associated with *E. coli* O157:H7 contamination (Fig. 22.1). Three other outbreaks were related to *Cyclospora* and one to *Salmonella*. None of the previous foodborne illness outbreaks linked to leafy greens had the number of illnesses and deaths, negative publicity, market impact, or industry response of the 2006 outbreak associated with spinach. Over this period, only two outbreaks were associated with spinach, but they accounted for all five deaths associated with leafy greens.

Although the spinach outbreak received a great amount of publicity, it was not the largest outbreak linked to produce in terms of illnesses. The 1996 outbreak associated with *Cyclospora* contamination of Guatemalan raspberries sickened 1,465 people in the U.S. and Canada, but no one died. Nor was the outbreak linked to spinach the most deadly. Although it is sometimes difficult to attribute death to a particular cause, the 2003 outbreak associated with green onions from Mexico contaminated with the

Table 22.1. Foodborne illness outbreaks attributed to produce, 1996–2006

Commodity	Outbreaks
Leafy greens	
Lettuce	14
Mixed lettuce	1
Romaine lettuce	4
Spinach	2
Cabbage	1
Basil or mesclun lettuce mix	2
Tomatoes	12
Melons	
Cantaloupe	7
Other melons	4
Raspberries and other berries	6
Herbs	
Basil	4
Parsley	2
Green onions	3
Almonds	2
Green grapes	1
Snow peas	1
Squash	1
Unknown	2
Total	71

Source: U.S. Food and Drug Administration.

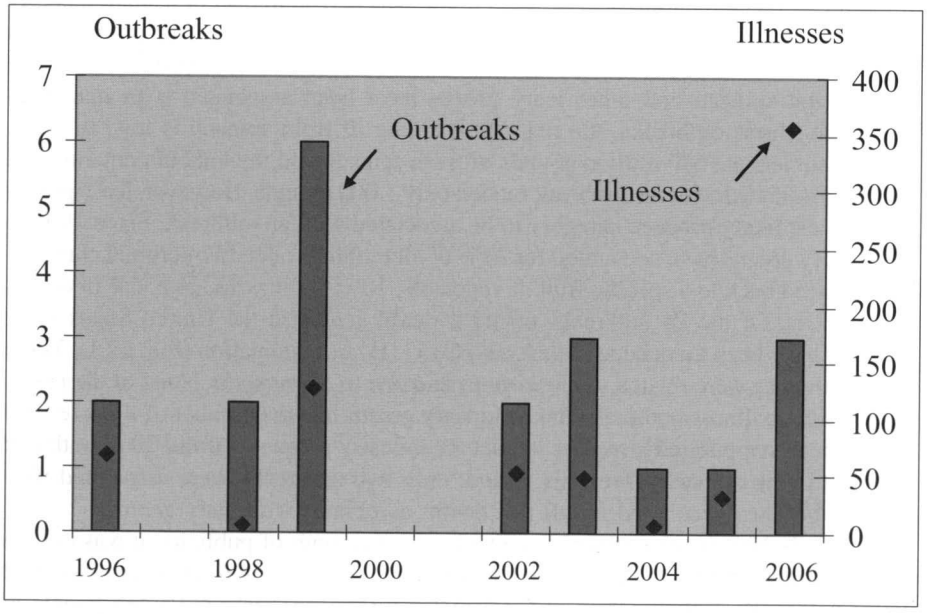

Figure 22.1. *E. coli* O157:H7 outbreaks (vertical bars) and illnesses (diamonds) linked to leafy greens, 1996–2006. *Source:* U.S. Food and Drug Administration.

hepatitis A virus was linked with 4 deaths. However, the outbreak linked to spinach was probably the biggest in terms of industry impact, primarily because of the FDA's announcement to the public to immediately stop consuming bagged spinach.

With so much at stake in terms of the loss of consumer confidence and potential for involvement by the federal government, the industry needed to mount a strong response to the FDA action. By the beginning of the next marketing season (April 2007), the California leafy green industry introduced the California Leafy Green Marketing Agreement (LGMA). The LGMA is a voluntary state marketing agreement, which requires that any California leafy greens handled by signatories be produced according to the agreement's new food safety standards. Although the exact benefits associated with this agreement are uncertain, they are potentially large and reflect an assessment by the industry that the benefits of such action likely outweigh the costs of meeting the new standards.

This chapter begins with a description of the U.S. produce industry, with a particular focus on spinach and other leafy greens, and factors that relate to food safety. The next section reviews the response to food safety outbreaks, including the FDA's good agricultural practices (GAPs) and the leafy greens industry's LGMA, which contains its own Best Practices. The third section discusses the economics of adoption of GAPs and the LGMA standards. The fourth section examines the economic impact of the 2006 outbreak linked to spinach. We end with some conclusions regarding the role of economic factors in determining approaches to reducing food safety hazards in fresh produce.

The U.S. Produce Industry

U.S. consumers are eating more fruit and vegetables, with per capita consumption increasing 7% from 1990 to 2005. The increase in consumption varies by type of product, with vegetable consumption increasing by 8% and fruit consumption increasing by 6%. The vegetable per capita consumption statistics include selected vegetables and potatoes, but do not include mushrooms, sweet potatoes, dry peas and lentils, or dry edible beans. Fruit consumption statistics include selected fruit, but do not include tree nuts. Per capita statistics can be found in two annual ERS publications: *Fruit and Tree Nuts Situation and Outlook Yearbook* and *Vegetables and Melons Situation and Outlook Yearbook*. Total spinach consumption has grown more rapidly than the average, increasing 90% from 1992 to 2005, from 1.6 pounds per capita to 3 pounds per capita per annum. If there is a contamination problem associated with a certain commodity and consumption of that commodity goes up, the probability of an outbreak also increases correspondingly.

Overall, more produce is being consumed fresh than processed (canned, frozen, dried, or juiced) and the fresh produce share is growing. From 1990 to 2005, the percent growth in fresh consumption exceeded the growth in total consumption: 15% for vegetables and 90% for fruit (see Table 22.2). This shift toward fresh products also increases the associated food safety risk. Produce that is consumed uncooked, such as raw spinach, poses more risk than produce that has been treated with a kill step, such as cooking for fresh produce, heating for canned and frozen fruit and vegetables, or pasteurization for juice. Spinach consumption patterns have exhibited a

Table 22.2. Fresh fruit and vegetable consumption and imports

Item	Per capita consumption		Imported share of consumption	
	2005	1990	2005	1990
Fruit:[1]	*pounds*		*percent*	
Bananas	25.1	24.4	99.7	99.8
Apples	16.7	19.6	7.0	4.7
Oranges	11.7	12.8	4.6	0.9
Grapes	8.6	7.8	54.9	37.0
Strawberries	5.8	3.2	7.1	4.0
Pineapples	4.9	2.0	87.7	49.0
Peaches[2]	4.8	5.5	11.0	8.0
Avocados	3.5	1.4	40.9	10.5
Pears	2.9	3.2	21.3	12.5
Lemons	2.9	2.6	9.7	3.6
Grapefruit	2.6	4.4	4.0	0.9
Tangerines and tangelos	2.5	1.3	29.0	11.4
Limes	2.2	0.7	100.0	53.0
Mangoes	1.9	0.5	100.0	97.4
Cherries	0.9	0.4	8.1	0.2
Total fresh fruit[3]	100.5	92.5	45.6	34.9
Vegetables and melons:[4]				
Potatoes	42.4	46.7	6.3	5.9
All lettuce	31.6	31.5	1.8	0.0
Onions	21.0	15.1	11.0	10.1
Tomatoes	20.2	15.5	35.0	20.5
Watermelon	14.0	13.3	15.9	6.9
Cantaloupe	9.8	9.2	32.8	23.0
Carrots	8.8	8.3	7.5	5.9
Sweet corn	8.8	6.7	2.2	0.9
Cabbage	8.1	8.3	4.8	4.2
Cucumbers	6.3	4.7	50.9	33.7
Broccoli	5.6	3.4	11.0	2.5
Spinach	2.3	0.8	3.7	1.5
Snap beans	1.8	1.1	11.3	11.2
Cauliflower	1.5	2.2	4.2	4.0
Asparagus	1.1	0.6	72.2	29.8
Total fresh vegetables and melons [5]	215.6	188.2	16.9	9.9

NA = not available

[1] For citrus, the year reflects the end of the harvest; for noncitrus, the beginning of the harvest.

[2] Trade numbers include nectarines.

[3] Includes bananas.

[4] ERS traditionally reports melons with vegetables. Consumption is on a calendar-year basis.

[5] Does not include potatoes, sweet potatoes, or mushrooms.

Source: *Fruit and Tree Nut Yearbook*, and *Vegetable and Specialties Yearbook*, ERS, USDA.

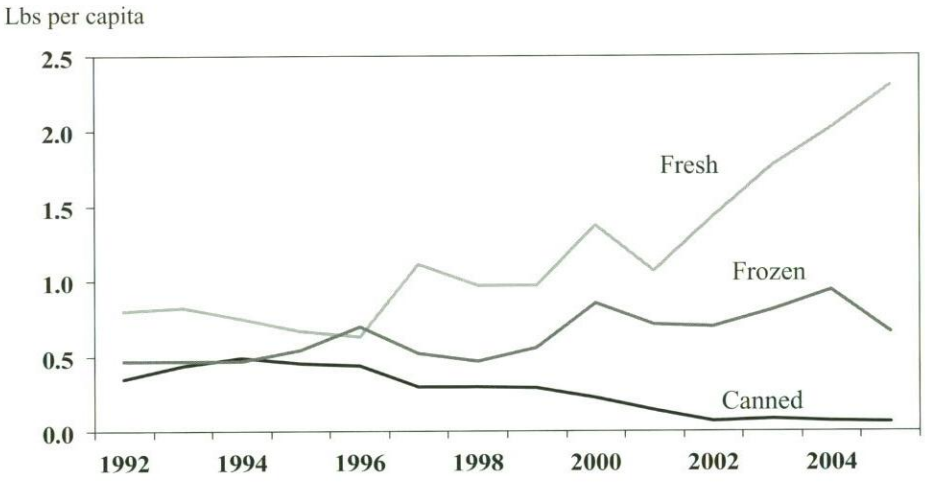

Figure 22.2. Changing spinach consumption pattern 1992–2005. *Source:* USDA—National Agricultural Statistics Service.

large change, with fresh per capita consumption increasing significantly from 1992 to 2005 (for example, see Fig. 22.2). Fresh-cut produce, including bagged salads, has become a more important part of the U.S. diet. The fresh-cut and bagging technologies are relatively new and the added convenience of washed and bagged spinach has probably contributed to the growth in fresh consumption.

Consumers are eating a more varied diet. The typical grocery store carried 345 produce items in 1998 compared with 173 in 1987. Some of these items are new and exotic products, new varieties of more familiar products, or new formats, such as more bagged or ready-to-eat produce items. Spinach and leafy greens have also followed this pattern. A typical bag of spring mix may contain arugula, radicchio, mizuna, frisée, etc.—products that were unknown to most consumers in 1990.

In addition to variety, consumers want produce on a year-round basis. Items that used to be available only seasonally are now imported to meet that year-round demand of consumers. In fact, this is not a new trend. In 2005, 46% of fresh fruit consumption was imported and 17% of fresh vegetable consumption was imported. In 1975, almost 22% of U.S. fresh tomato consumption was imported. Imported products help meet the demand for year-round fresh product, and they may also help dampen fluctuations in seasonal prices of fruits and vegetables. If the U.S. had to depend only on Florida tomatoes in the winter, consumers would face higher prices. Augmenting the winter tomato supply with imports from Mexico benefits consumers, but it does not benefit Florida producers.

Although the general trend is toward an increasing share of imports in the total supply of fruit and vegetables in the marketplace, the role of import shares varies widely across the spectrum of products (Table 22.2) and depends on many factors including production possibilities (e.g., season), production costs including labor, transportation, and opportunities for storing product. Imports play a very small role

in the spinach and leafy greens market. In 2006, only small volumes of fresh-market spinach and lettuce were imported: 3% of spinach for domestic consumption came from imports, 2% of head lettuce, and 1% of leaf and romaine lettuce.

Despite several widely publicized cases, imports do not necessarily pose more of a risk than domestic products for food safety hazards, and no statistically reliable surveys are available to compare safety. Many U.S. buyers require the same food safety practices for imports as they do for domestic production. New production anywhere may be more problematic than production practiced by experienced growers. Food safety is a learning process and adjusting to local microbial risks may take time. In addition, many locations lack infrastructure (such as safe water supplies), and adopting food safety practices may be particularly challenging for foreign growers in such areas producing for the U.S. market (Dong and Jensen 2008). However, many well-established export industries in foreign countries have met this challenge, as evidenced by the significant share of product imported without incidents or food safety problems.

The case of raspberries from Guatemala provides an example of a problem with imported produce (Calvin 2003). In the late 1980s Guatemala started to export fresh raspberries to the United States in the spring and fall. It was a new export crop for Guatemala and it filled a lucrative market niche between Chilean winter supplies and the beginning of U.S. summer production. Annual outbreaks in the U.S. and Canada from 1996 through 2000 were linked to Guatemalan raspberries contaminated with *Cyclospora*, a parasite that no one knew much about at that time. The FDA issued import alerts on fresh raspberries from Guatemala for several years. Extensive and costly efforts to improve food safety did not solve the problem, and 2003 was the last year with substantial exports of the product from Guatemala. Mexico, which began raspberry exports to the U.S. about the same time as Guatemala, has not been linked to any outbreaks and is now the largest supplier to the U.S. market, followed by Chile (Fig. 22.3).

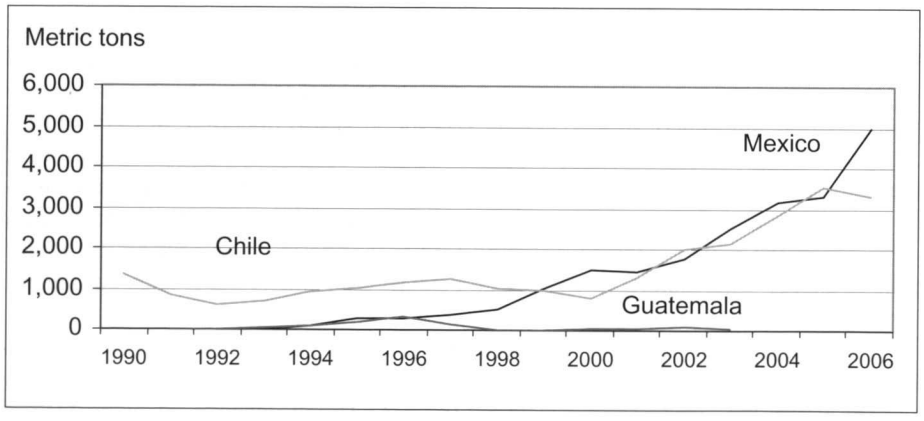

Figure 22.3. U.S. import of raspberries from Guatemala, Mexico, and Chile, 1990–2006. *Source:* U.S. Department of Commerce.

Much of the U.S. produce industry is concentrated geographically in just a few states. For example, in 2006 California accounted for 51% of the value of fresh-market vegetables produced in the United States. Large firms that provide a year-round or extended-season supply dominate in these areas. Many smaller growers produce fruit and vegetables seasonally in other states, often for local markets. Spinach demonstrates this concentration. In 2005, 75% of the U.S. fresh-market supply of spinach grew in California (Fig. 22.4), with 54% of the U.S. total grown in the three adjacent counties of Monterey, Santa Clara, and San Benito. Arizona, Texas, New Jersey, Colorado, and Maryland combined to account for about 25% of the 2005 fresh-market spinach production. These statistics come from the USDA's Agricultural Marketing Service, which records shipments just from the largest production area, unlike the U.S. Census, which records all production areas.

Today, fresh fruit and vegetable products move quickly from producing regions directly or via market intermediaries to retail and food-service buyers (Calvin and others 2001). Retail consolidation has resulted in shipper consolidation. Retailers and food-service buyers do not want to deal with a large number of small shippers when a few larger shippers could supply their needs. As both retailers and shippers consolidate, it has become easier to specify desired production practices to obtain a uniform product. Some, but not all, of this coordination has been achieved through increased use of contracting and vertical integration within the marketing and procurement channel.

Industry structure has several implications for food safety. It is generally easier to get major players to cooperate in a food safety initiative when production is concentrated in a state. Crossing state lines may involve more types of growers, different production practices, and less agreement on issues. The LGMA illustrates these challenges. The voluntary marketing agreement in California had virtually 100% participation in its first year. Arizona also initiated a similar marketing agreement. Many of

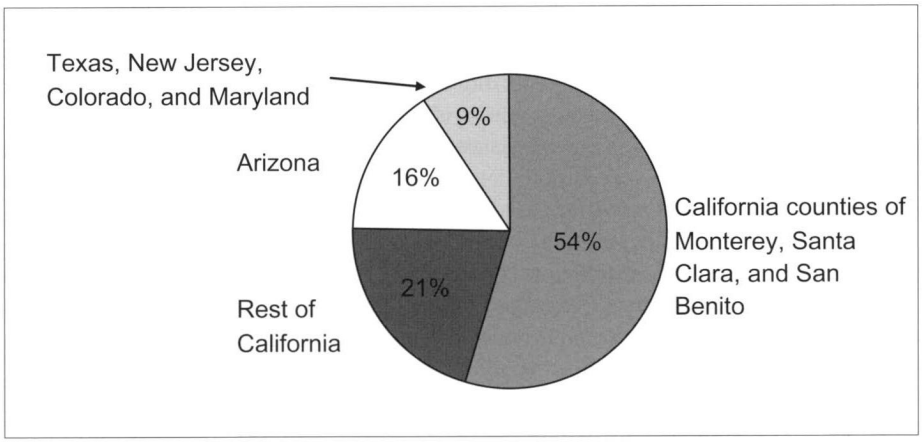

Figure 22.4. U.S. fresh-market spinach production, 2005. *Sources:* USDA—National Agricultural Statistics Service and California Agricultural County Commissioners' data.

the large California shippers also operate in Arizona. However, when the U.S. Department of Agriculture (USDA) issued a call for comments on the idea of having a national marketing agreement or marketing order, many smaller producers protested due, in part, to the expected high costs of complying with such an agreement.

Consolidation in the produce industry means that any food safety problem that affects one grower or shipper may affect a large number of consumers, and be more likely to be detected. The capital-intensive bagged salad industry is particularly concentrated. In 1997, the top two firms accounted for 76% of the retail sales of bagged salads, the top five firms accounted for 88% of sales, and private label firms accounted for 10% of sales (Calvin and others 2001). At the same time, large firms may have the financial resources and the volume of sales to adopt some of the food safety practices, which may be relatively expensive for smaller companies.

Government and Industry Response to Food Safety Problems

In the mid-1990s, outbreaks of foodborne illnesses linked to microbial contamination of both domestic and imported produce focused attention on the potential for contamination at the farm level. In 1996, *E. coli* O157:H7 was linked to California lettuce associated with farm-level contamination. This was in addition to the foodborne illness outbreak linked to imported Guatemalan raspberries, also contaminated at the farm level. The economic impacts of the outbreaks made it clear to the produce industry, particularly those sectors associated with the contaminated product, that improved food safety programs were necessary. The U.S. government also became more involved in produce food safety at the farm level.

The appropriate regulatory approach to promote food safety depends on both the type of product and the hazard. The government can either regulate the product or the production process (Unnevehr and Jensen 2005). When monitoring the quality of products is feasible, *product standards* are likely to be more efficient than *process standards* because they allow firms to meet the minimum quality or tolerance levels but choose the least expensive method to do so. In addition, since the potential for contamination may vary across farms, locking all growers into the same process standard may not be appropriate. However, in instances when determining product quality is difficult or very costly, requiring certain processes to be followed provides an effective strategy for reducing product risk.

Two characteristics of fresh produce work against product standards for microbial contamination. First, it is very hard to detect microbial contamination on produce. The FDA product standard is zero tolerance for microbial contamination, but this is largely unenforceable. Microbial contamination on produce can be difficult to detect. In contrast, testing for pesticide residues is relatively efficient. If a field is sprayed with too much pesticide, any produce from that field will turn up positive for excessive residues. Microbial contamination on produce can be at low levels and occur sporadically. Only a small section of a field, or even just one leaf of lettuce, may be contaminated, and the chance of detecting that contaminant in random testing is low. Second, there is no generally approved methodology for removing microbial contamination from fresh produce, so the most effective strategy for reducing the risk of microbial contamination is prevention. Until recently, the FDA had approved irradiation of fresh

produce only for controlling quarantine pests (e.g., irradiating mangoes for fruit fly). In 2008, the FDA approved irradiation of leafy greens to reduce microbial contamination, which may provide an alternative strategy for this segment of the produce industry. The FDA does not have a process standard, but the produce and buying industries are developing process standards.

In 1998, the FDA published voluntary guidelines, GAPs, to help growers, both domestic and foreign, reduce the risk of microbial contamination at the farm level. The FDA specified particular areas of risk (water, manure, and municipal biosolids, worker health and hygiene, sanitary facilities, field sanitation, packinghouse sanitation, transportation, and traceback) that should be addressed but did not specify particular production practices. GAPs are guidance, not a process standard. This was a general, common-sense guide, because, at that time, there was very little specific research to provide more concrete advice.

Over time, there has been a push to develop more specific guidelines. In 2004, the FDA and the Centers for Disease Control and Prevention (CDC) met with produce industry leaders to discuss numerous foodborne illness outbreaks associated with produce. At that meeting, industry representatives agreed to take the lead on developing commodity-specific GAPs that would provide additional guidelines tailored to individual commodities that had been implicated in recent foodborne illness outbreaks.

After the 2006 outbreak linked to spinach, the California leafy greens industry developed a set of Best Practices (also known as *the metrics*) that would become the standard for the LGMA. This is a process standard required for all participants and verified with mandatory audits; it is not guidance. Unlike the FDA's initial guidance document and the commodity-specific GAPs, the new Best Practices defines practices with specific criteria and target values for controls and monitoring. As an example, the original GAPs document warned farmers that "water quality should be adequate for its intended use." At the time, the FDA was justifiably reluctant to specify what adequate water quality was because it did not have enough data to support specific thresholds. The new Best Practices are much more specific, but the science is still relatively weak. For example, the standards for well water require testing before production begins and monthly testing during the production season. The document recommends specific tests for measuring levels of generic *E. coli* in the water and an action plan to be applied if counts reach certain numerical thresholds. However, the effectiveness of these practices under different growing conditions as well as the costs are not well understood.

There have been some industry and consumer calls for the FDA to step in with mandatory process standards. Although the FDA does not currently have food safety process standards with respect to microbial contamination for the fresh produce industry, it could impose mandatory food safety standards if deemed necessary. However, developing process standards without adequate scientific support could undermine public confidence in food safety regulators if another outbreak occurred. The FDA has imposed mandatory standards on fruit juice. In the late 1990s there were three foodborne illness outbreaks associated with unpasteurized fruit juice. In 1998, the FDA published a rule requiring juice processors to use Hazard Analysis and Critical Control Point (HACCP) principles to reduce risk. Processors are required to use processes that

achieve a 5-log reduction in the numbers of the most resistant pathogen in their finished products, compared to levels that may be present in untreated juice. In most cases, this level of reduction is achieved with pasteurization. There is no corresponding easy solution for fresh produce.

There is a proliferation of other process standards. Many private firms (growers and buyers) have developed their own process standards. Buyer organizations have also developed process standards. The Food Marketing Institute holds the U.S. licensing rights for Safe Quality Food (SQF), an Australian process standard. The Food Safety Leadership Council proposed its own process standard but faced protests from the produce industry. The future of that specific process standard is uncertain. As a result of the explosion of standards, growers are paying for numerous third-party audits of food safety practices, which can lead to a considerable expense.

Economics of Adoption of GAPs and the LGMA

GAPs are now an important part of the produce industry in the United States and countries that export to the U.S. The private third-party audit industry has taken the guidelines and developed audits to certify whether growers are complying with the FDA guidelines or any other guidelines or process standards that a grower or buyer might use.

Foodborne illness outbreaks related to produce continue. Either growers are not using GAPs or are not using them correctly and consistently, or GAPs do not sufficiently target the relevant risks. The conventional wisdom suggests that large producers in high-risk commodities use GAPs, but there is no statistical evidence to support this assumption for the U.S. fresh produce industry.

A survey of green onion exporters in Mexico (the major source of green onions consumed in the U.S.) in 2002, the year before the large outbreak linked to Mexican green onions, found that three of seven growers had already adopted GAPs and two of seven growers were in the process of doing so (Calvin and others 2004). Although the survey's sample size is small, the industry was concentrated with just 26 growers in 2002. None of the growers associated with the 2003 outbreak linked to Mexican green onions had third-party audits of GAPs. After the outbreak, Mexican growers developed a mandatory food safety program, so that the practices of a few growers could not undermine the reputations of others.

Many California leafy greens growers already had GAPs before the 2006 outbreaks linked to spinach. With repeated outbreaks traced back to leafy greens, it is thought that most large retailers and food-service buyers were demanding GAPs from their suppliers. Also, because there are very large bagged salad producers with consumer-recognized brand names, these producers would have more incentive to adopt GAPs than others who were not invested in maintaining a brand name.

Private Benefits and Costs

When individual growers consider whether to adopt additional voluntary food safety practices, they weigh their private benefits and costs. Typically, growers adopting a new production practice expect to either receive a higher price (i.e., price premium) for a higher-quality good, reduce risk, or lower their costs of production. In the case

of adopting food safety practices, growers have generally not been able to charge a higher price for a product grown with more attention to food safety (discussed in more detail below).

Other benefits may influence growers' decisions to adopt better food safety practices. These benefits are mostly related to reducing risk. Growers want to reduce the probability of an outbreak being traced to their firm that could cause lost sales, damage to reputation and brand name, costly lawsuits, etc. These benefits accrue only in the event of an outbreak. Before an outbreak occurs, some growers may think that the probability of experiencing these benefits is very low. A more immediate benefit of adopting better food safety practices is that it satisfies many retailers and food-service buyers who require third-party audits of grower food safety practices as a precondition of purchase. Having higher food safety practices gives growers broader market access, which is an important competitive advantage and incentive to adopt GAPs.

A primary factor weighing against the potential benefits of adopting new food safety standards is the costs, which are immediate and often large. Growers want to reduce the risk of outbreaks, but unless the contamination mechanism is understood, it is not clear whether additional practices will reduce risk or just raise costs. The lack of relevant science may limit opportunities to control risk (Hennessy and others 2003). Perfect safety for products grown in a natural environment is not attainable (the FDA acknowledges that no practices guarantee perfect safety) and a grower could go broke trying to approach that elusive goal.

Costs of adopting new food safety practices include both recurrent and nonrecurrent costs. Nonrecurrent costs may entail investments in water quality and waste management infrastructure, harvest machinery, and packinghouse facilities. Recurrent costs of compliance may include higher costs for water, water testing, training workers in hygiene in the field, upgrading data collection and record keeping systems, etc.

In the case of the new California LGMA, several new practices are expected to be quite expensive, such as water testing, record keeping, and buffer zones. Before the outbreak, some growers had already adopted some of these new practices, and their costs of adopting the rest will be lower than the costs for growers who had more limited food safety programs and have to adopt all the safety practices at the same time. Costs will also vary among farmers. Smaller farms may find the costs of record keeping and related training difficult to meet as they try to spread the cost over a lower production base. The buffer zone costs will vary by location, with farms in outlying areas with more risk of wild animal intrusion or near cattle operations needing to consider more remedial actions than growers surrounded only by other leafy greens fields. Some retailers and food-service buyers are requesting additional practices such as final product testing, which will also raise the costs of being a leafy greens grower in California.

Growers adopt new food safety practices if expected benefits exceed expected costs. However, not all growers make the same decisions with respect to adopting more food safety practices. Even among growers of the same crop, benefit-cost analyses upon which decisions are based can vary depending on characteristics of the growers and their operation. Early adopters have more choices. At some point, new practices become the industry standard, and those who did not adopt early in the process must finally adopt if they want to remain competitive.

A market that accommodates separate prices for products grown with different levels of food safety practices with respect to microbial food safety has not developed. Because growers cannot necessarily recoup the costs of increased food safety, not all adopt new practices. The outbreak linked to spinach provides an interesting example of this problem. Other recent outbreaks have largely dealt with bulk commodities. The leafy greens industry has both bulk and value-added bagged salad products, and each segment has fared differently in its ability to increase prices to cover additional costs of improved food safety practices.

Several large firms of bagged salads raised their prices after the outbreak from spinach. Consumers might miss their favorite salad if a retailer refused to pay the price increase. Also, with such a high level of concentration, if a very large retailer rejected a request for a higher price from a large bagged salad company, the retailer might have a hard time getting enough replacement product. Bagged salads are largely sold via long-term contracts, and if firms did not raise their prices after the outbreak, they tried to raise them when their contracts were next renewed. It is not clear whether smaller companies were as successful as the larger companies in renegotiating contract prices.

With bulk leafy greens, only a small portion is sold via long-term contracts and firms are gradually trying to raise prices as contracts are renewed, just as the bagged firms did. But the majority of bulk leafy greens are sold at the daily market price where price is set by supply and demand; there has been no price increase for bulk spinach or lettuce where one grower's product is essentially indistinguishable from another's. Of course, in the long run, prices must rise to cover costs, or growers will stop growing leafy greens, although this can sometimes be a slow adjustment process.

Immediately after the outbreak, many retail and food-service buyers joined a call for better food safety standards in the leafy greens industry. When the California industry put the LGMA into operation, they asked buyers to agree to buy only leafy greens from California from signatories to the agreement. With only a few exceptions, buyers generally refused to sign such an agreement. But if a large share of buyers had signed such an agreement and LGMA participation fell substantially, there could be a situation where there would be two markets, with one price for products grown with the LGMA and one price for those grown outside the agreement. The price in the segment grown with the LGMA would vary depending on supply and demand conditions in that segment alone. Buyers pledged to purchase only from LGMA members would not be able to buy from the others while honoring their agreement. The segment grown outside the LGMA would respond to its own supply and demand conditions as well as those in the LGMA group, with buyers able to buy from any supplier.

Public Benefits and Costs

The decisions individual growers make about food safety practices may not ensure the level of food safety desired by consumers and society at large (Caswell and Mojduszka 1996). Markets do not always work smoothly for all goods. Private decisions by growers may not be socially optimal because of imperfect information and negative externalities.

Imperfect information, which exists when buyers and sellers cannot identify certain characteristics of a product, may reduce the incentives to adopt new food safety

practices by hindering the development of different prices for different levels of food safety. In the past there was never a separate spot-market price for produce grown with GAPs and produce grown without GAPs, even when imperfect information is reduced with the use of third-party audits. Perhaps food safety is an inherently different quality than other unobserved characteristics. For example, organic production, an unobserved characteristic, enjoys a price premium over conventional production. But organic is something beyond and above conventional production. Consumers may feel that only safe food should be offered and are unwilling to pay extra for that characteristic. Or retailers and food-service buyers may not be willing to pay more for food produced with more food safety attention.

Advertising product from one producer as being safer may be a risky strategy for a retailer or food-service firm because in most cases it is not actually possible to guarantee food safety. Retailers often have to change suppliers if there are weather problems in particular areas. What if that product was produced with less attention to safety? A retailer or food-service buyer would hardly want to advertise that fact. Also, advertising differences in safety among sources of a particular produce item may provide consumers with information that undermines their confidence in the product in general, regardless of the food safety claims, especially if consumers never knew that kind of contamination was possible on produce (Golan and others 2004).

Negative externalities also affect the incentives to adopt additional food safety practices. Negative externalities occur when one party's production or consumption choices have a negative impact on another party's well-being. Society as a whole may demand higher levels of food safety than consumers in grocery stores or food-service establishments. Of course, in the event of an outbreak of foodborne illness, consumers are on the front line facing health problems and medical bills, lost days of work, etc. Everyone along the marketing chain associated with the contaminated product will face potential costs. Even those not directly associated with contaminated product may suffer. For example, if a foodborne illness is traced to a particular product, but not a particular grower, all producers of that food item may feel the effects of decreased demand, as shown by the drop in shipments and fall in price of fresh bunched spinach shipments following the FDA announcement in September 2006 (Fig. 22.5). The CDC and FDA incur substantial costs in tracing back the outbreak to the contaminated product. They also investigate farm and packinghouse operations and review inspection results. Some level of government often ends up paying for many of the medical costs incurred in an outbreak. In their private benefit-costs analyses, growers do not consider the benefits and costs that others might incur if food safety were improved, and may, therefore, provide less food safety than society desires.

When there are outbreaks of foodborne illness, other groups in the produce industry, marketing chain, or government may face increased costs and may try to impose new rules on growers to encourage or force them to implement food safety measures more in line with society's total demand for food safety. Essentially, the costs of organizing to bring about the changes have decreased. For example, grower organizations may put into place voluntary or mandatory practices to reduce the negative impact of one producer with contaminated produce on other growers of the same product. The LGMA is an example of this type of response. Retailers and food-service buyers may require third-party audits showing grower compliance with GAPs and

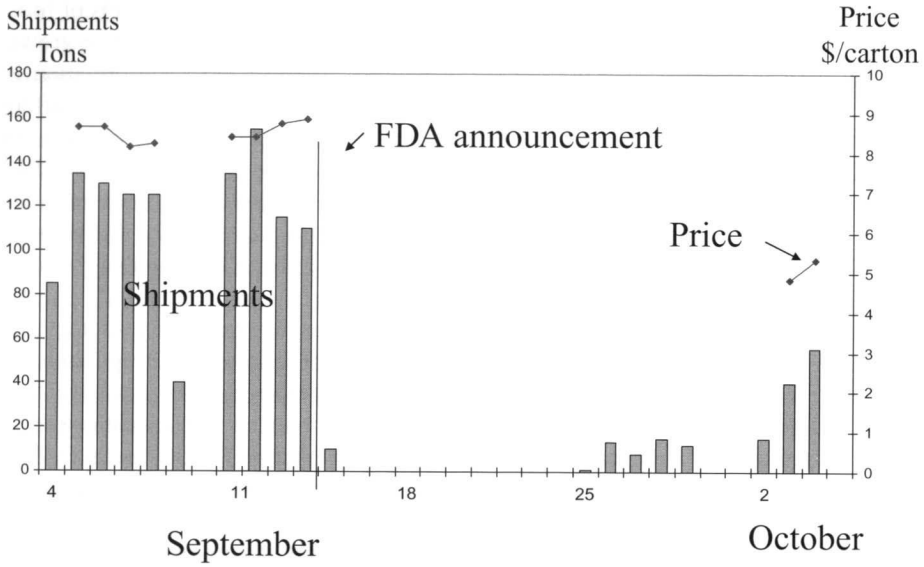

Figure 22.5. Fresh bunched spinach shipments: September–October, 2006. *Source:* USDA—Agricultural Marketing Service.

packinghouse compliance with good manufacturing practices (GMPs) to reduce the chance that their businesses will be associated with an outbreak.

Economic Impacts of the Spinach Outbreak

After the FDA's announcement on September 14 not to eat bagged spinach (followed the next day by the announcement not to eat any fresh spinach) there was no U.S. spinach on the market for 5 days until after the FDA announced on September 19 that all spinach from outside California was safe to eat. Figure 22.5 shows a timeline of bulk spinach shipments in September–October 2006 (USDA has shipment data only for bulk spinach, which is estimated at 10–25% of total fresh-market spinach). Data do not show shipments from outside of California that might have resumed after September 19. On September 22, the FDA announced that spinach from California, except Monterey, Santa Clara, and San Benito, was safe, and small sales resumed. On September 29, the FDA announced that "spinach on the shelves is as safe as it was before this event." At that stage there were no restrictions on any spinach, except for the four fields that the FDA was still investigating, and bulk spinach sales began to grow slowly.

Retail sales data show a more complete picture of the impact on the sector's sales and loss in economic value (Table 22.3). Retail data are available from Information Resources, Inc. and FreshLook Marketing. The data cover sales by major retailers but not "big box" stores. The food-service market is very important for leafy greens but no data were available. Members of the leafy greens industry reported that the food-service market recovered faster than the retail market. In 2005, the year before the

Table 22.3. Leafy greens retail market shares and changes in sales

Commodity	Share of Leafy Greens Sales 2005	2004–05	Change in Sales Quantity		
			2005–06 (Jan–Aug)	2005–06 (Sep–Dec)	2005–2007
	percent				
Romaine hearts	7	13	10	10	7
Spinach in bags[1]	5	7	8	–49	–13
Bagged spring mix	2	6	22	–14	13
Salad without spinach	47	1	–6	–8	–9
Bulk romaine	6	0	0	14	–3
Bulk iceberg lettuce	24	–3	–6	–4	–11
Bulk leaf and other bulk lettuce	7	–4	–5	7	–5
Bulk spring mix	1	–4	–7	–15	–14
Bulk spinach[2]	1	–9	–2	–44	–21
All leafy greens	NA	1	–3	–6	–7
All other vegetables	NA	3	0	–1	3

NA = not applicable.
[1] Does not include bagged spring mix.
[2] Does not include bulk spring mix.
Source: IRI and FreshLook.

outbreak, products with spinach accounted for only 9% of the total volume of leafy greens sales. Bulk spinach sales accounted for only 1% of the retail sales volume (in pounds) and its share was declining. Spinach in bags represented 5% of spinach and lettuce product sales. This category includes bagged salads, both those containing just spinach and those containing a spinach-lettuce blend, as well as bags of spinach that might be intended for cooking. Bagged spring mix, which usually contains spinach, represented another 2% of the market. Bulk spring mix accounted for about 1%.

Between 2004 and 2005, sales of spinach in bags grew 7%. Spring mix in bags was growing rapidly. It was the third fastest growth item in 2005, after romaine hearts and spinach in bags, and was up 6% over the previous year. In the first 8 months of 2006, spring mix was the most rapidly growing category, up 22% from the same period in 2005. Bulk spinach and bulk spring mix were declining in sales as were all bulk lettuces.

Lettuce shows a very similar pattern to spinach, with all bulk products declining in share and all value-added products increasing in share. Although bagged salads without spinach accounted for 47% of total spinach and lettuce sales in 2005, it was not growing very much. Romaine hearts (value-added product often sold in bags) were the most important growth area for lettuce. Iceberg was the largest category of bulk lettuce, followed by leaf and other lettuces, and then bulk romaine.

Evaluating the last 4 months of 2006 provides a better view of the impact of the outbreak. In the last 4 months of 2006 after the FDA announcement, sales of all products containing spinach plummeted compared to the same period in 2005. Spinach

in bags, the product that was implicated in the outbreak, was down 49% and had the largest decline. Bulk spinach was down 44%. Bagged and bulk spring mix sales were down 14% and 15%, respectively. The smaller impact on spring mix may be because consumers were unaware that this product usually contained spinach or they may have responded to the leafy greens industry taking spinach out of the mix.

Other lettuce products were also affected by the problems associated with spinach, most notably the increase in sales for bulk romaine, bulk leaf, and other bulk lettuces. These are the only two categories that grew in sales. Also, with the outbreaks of foodborne illness associated with iceberg lettuce in December, they were the only categories of lettuce untouched by food safety shocks. The growth in romaine hearts sales did not change in the aftermath of the outbreak. Consumers may have been more concerned about romaine in bags than bulk romaine.

The impact of the outbreak on spinach has been quite long-lasting. Figure 22.6 shows sales of spinach in bags from 2005 to 2007. 2006 sales were above the 2005 levels until the September 14, 2006 announcement by the FDA when they plunged immediately. At the end of 2007, over 15 months later, sales volume still lagged behind the levels of 2005. It is not clear whether there is a permanent shift in consumer demand for spinach or whether consumers are still adjusting to the shock and may eventually buy more bagged spinach and continue preshock trends. Producers also cut back on spinach acreage with total U.S. fresh-market spinach production down 16% from 2005 to 2007.

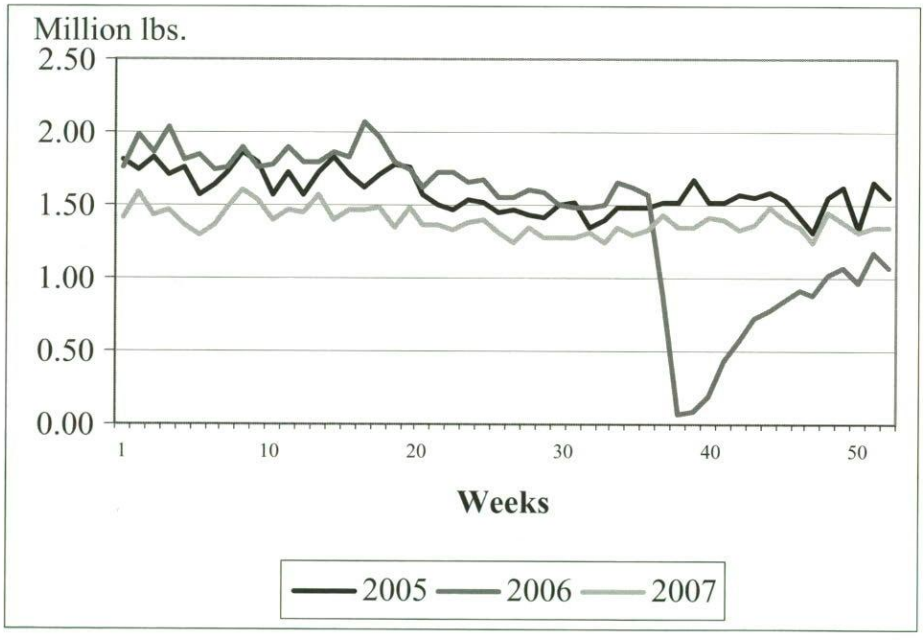

Figure 22.6. Spinach in bags; retail sales 2005-2007. *Source:* IRI and FreshLook Marketing.

Research on the observed market impact of outbreaks is limited. In the case of the 2003 outbreak of hepatitis A associated with green onions from Mexico (the major supplier of green onions in the U.S. market) shipments lagged behind the previous year's level for about 5 months (Calvin and others 2004). Research on strawberries in the 1990s showed that consumption is affected more by negative news than positive news after an outbreak (Richards and Patterson 1999). In the fall of 2006, the leafy greens industry faced three different batches of bad food safety news after the spinach problem. One recall turned out to be a false alarm. In December, two outbreaks in fast-food restaurants were linked to lettuce. In 2007 there was another false alarm and two recalls of contaminated products but no illnesses were reported in either case.

Outbreaks can also have an impact on U.S. export markets. Canada is the largest export market for U.S. leafy greens. In the case of the 2006 spinach outbreak, Canada briefly blocked imports of spinach from the U.S. Even after the market reopened, trade was low (Fig. 22.7). Canadian consumers, like U.S. consumers, were probably less likely to consume spinach after all the adverse publicity. Volume over the last 4 months of 2006 was down 49% from the previous year. Beginning in June 2007, Canada started limiting imports of leafy greens from California to signatories of the LGMA. Although Mexico is a very tiny market for U.S. leafy greens it also followed the Canadian example, first briefly banning imports of leafy greens and now limiting California imports to those from members of the LGMA.

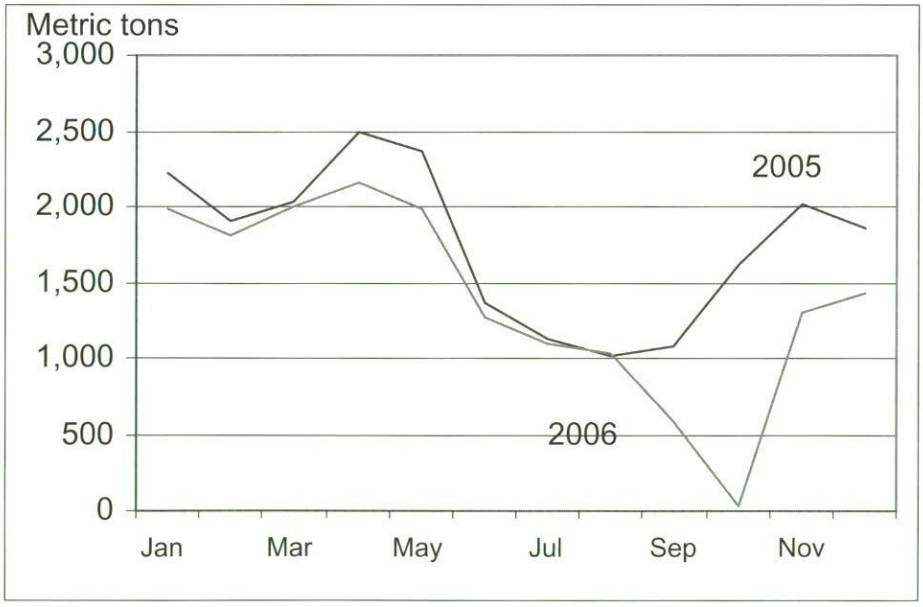

Figure 22.7. U.S. fresh spinach exports to Canada, 2005–2006. *Source:* U.S. Department of Commerce.

Conclusions

The market for fresh produce today includes a wide range of products available year-round. An increasing share of the products are consumed fresh and not processed. Many of the products are imported at some time during the year. Several well-publicized cases of foodborne illnesses illustrate the food safety hazards with fresh produce. Raspberries from Guatemala, green onions from Mexico, and spinach/leafy greens from California all show the potential extent and magnitude of harm caused by breakdowns in food safety. The contamination of fresh spinach with *E. coli* O157:H7 in September 2006 led to over 200 people becoming ill and a shutdown of the spinach industry for a short period of time. These cases all show the potential for high costs in terms of public health and to the industry from failure to control the hazards.

We draw three main conclusions and observations about economic conditions and factors that affect food safety in fresh produce. First, in the case of the spinach and leafy greens industry, the concentration of the major production in a relatively limited number of states and the consolidation of major growers in the marketing and procurement channels facilitated the organization of growers developing and enforcing a voluntary industry agreement through the LGMA on the use of Best Practices in production and processing. Where such voluntary agreements may be more difficult to develop, individual growers will continue to determine their own level of food safety.

A second conclusion is that the distribution of costs of controlling food safety in the system can have an important impact on the structure of the industry. With new concerns about safety, some areas or sizes of firms may not be as competitive as they once were. For example, certain areas may have more problems controlling water quality. Other environmental conditions in some areas may make production more prone to food safety problems. Also, economies of scale in certain processing technologies or practices associated with reduced product risk would favor large firms. In an extreme case, the inability of the Guatemalan raspberry producers to control the *Cyclospora* contamination problem led to the demise of their industry in the U.S. marketplace. This problem gave the raspberry industry in Mexico a competitive edge in the U.S. marketplace, at least temporarily.

Finally, increasingly integrated global markets for fresh produce require that suppliers and buyers make and receive assurances of food safety practices. Use of third-party audits of various food safety practices is increasing among U.S. growers and foreign growers who produce for the U.S. market.

As illustrated by the 2006 food safety outbreak related to spinach, the effects of an outbreak on an industry can be significant. To date, the food safety outbreaks for leafy green produce have hastened and encouraged the ongoing adoption of safety-related practices and technologies. With so much at stake for the health of the consumer and the industry, it is important that science lead the way in identifying good practices to reduce the risk of microbial contamination and ensure the cost-effectiveness of new investments.

Acknowledgments

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